Attorney Docket # 502902-210PUS   PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	Examiner: Farokhrooz, Fatima N.
Bert BRAUNE et al.	Group Art: 2889
Serial No.: 10/552,936	
Filed: October 11, 2005	
For: Luminophore-Based LED and Corresponding Luminous Substance	

Commissioner for Patents
P.O. Box 1450
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DECLARATION OF FRANK JERMANN

FRANK JERMANN hereby declares and states that:

1.   We are the inventors of the subject matter disclosed in the above-identified patent application.

2.   This declaration is presented to show the criticality of the concentration of a rare earth element of approximately 0.1 to 1 mol %, and optimally 0.9 mol% of a component A of the garnet $A_3B_5O_{12}$.

3.   The attached graph was obtained at a lab of the University of Ulm at my request and shows the optical lifetime (ns) of YAG:Ce as a function of the Ce (activator) concentration (at%).

4.   The lower abscissa in the attached graph shows the Ce concentration (at%) relative to the number of atoms in the elemental formula of YAG ($Y_3Al_5O_{12}$). The upper abscissa shows the Ce concentration (at%) relative to only the Y atoms in the YAG formula.

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The number of whole atoms in one YAG elemental formula are 3 Y + 5 Al + 12 O = 20. There are three Y atoms in the YAG formula. Thus, the values in the abscissas are related by a factor of 20/3.

5.   In the claims of the above-referenced application, the Ce-concentration is given relative to Y (i.e., A in the garnet A3B5O12). Thus, the values recited in the claims correspond to the upper abscissa in the attached graph (mol% ≡ at%).

6.   According to the attached graph, the optical lifetime of YAG is significantly reduced and therefore exhibits strong quenching when the doping of Ce relative to Y is higher than the critical value of 0.9 mol%. That is, the level of quenching is optimized when the doping of Ce relative to Y is less than or equal to the critical value of 0.9 mol%.

7.   Also according to the attached graph, the maximum optical lifetime (97 ns), is achieved only for low doping concentrations of Ce (e.g., approx. 0.5 at %).

8.   The optical lifetime is shortened with increasing doping of Ce because the possibility of non-radiating energy transfer also increases with increasing doping because the distortion of the crystal lattice of the phosphor is increased.

9.   Thus, an increase of non-radiating energy transfer results in a decrease of emission efficiency. Non-radiating energy transfer is not useful when radiation (emission) is required, as in an LED. Stated another way, the longer the optical lifetime, the greater the phosphor emission efficiency.

10.   The above-described luminescence quenching at such a low Ce concentration occurs only with YAG nanophosphors. Thus, the Ce concentration is optimized at 0.9 mol% as described above.

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11.   An advantage of the YAG nanophosphors with Ce concentrations below 1 mol % and greater than 0.1 mol % is that chromaticity points lying in the green spectral range can be attained (i.e., the maximum emission of the phosphor (i.e., emission peak) shifts toward short-wave wavelengths) without significant efficiency loss (i.e., scattering is negligible) so that the absorption curve of the YAG:Ce lies under the peak wavelength of 460 nm of the primary emission source (i.e., the InGaN chip), and thereby, when put together with a second, red phosphor, enables high quality white light to be produced.

12.   In view of the above, the criticality of mol% of Ce relative to YAG is clearly shown.

13.   I hereby declare that all statements made herein of my own knowledge are true, all statements made on information and belief are believed to be true, and further that these statements were made with the knowled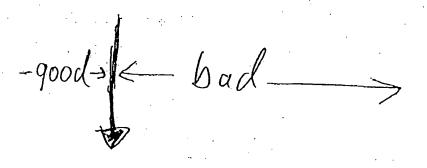ge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of title 18 of the United States Code and that such willful false statements may jeopardize the validity of this patent application or any patent resulting therefrom.

Date: _Oct 28, 2008_   _Frank Jesmann_
                                           Frank Jermann

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-good→ ←— bad ————→

0.9 at% of Y = 0.9 mol% of Y

0.66 1.32 2.0   4.0   <- Ce at% of Y

Strong quenching at high doping

Ce [at.%] of YAG

0.14 at%